APPENDIX E

Noise and Vibration Study

5150 EL CAMINO REAL
NOISE AND VIBRATION ASSESSMENT

Los Altos, California

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INTRODUCTION

The project proposes to demolish the existing office building, parking lot, and landscaping located at 5150 El Camino Real in Los Altos, California, and redevelop the site with two five-story condominium buildings and two three-story townhome buildings. In total, the project would provide 196 multiple-family residential units. The condominium buildings would provide 172 residential units and contain a mix of one- and two-bedroom units. The five-story condominium buildings would front on El Camino Real at the northern half of the project site, reaching a maximum height of 56 feet above grade and providing approximately 183,650 square feet of residential space. The townhome buildings would provide 24 residential units and would be located at the southern portion of the project site, adjacent to the rear property line. The townhome buildings would reach a maximum height of 30 feet above grade and provide approximately 45,200 square feet of residential space.

This report evaluates the project's potential to result in significant noise and vibration impacts with respect to applicable California Environmental Quality Act (CEQA) guidelines. The report is divided into three sections: 1) the Setting Section provides a brief description of the fundamentals of environmental noise, summarizes applicable regulatory criteria, and discusses the results of the ambient noise monitoring survey completed to document existing noise conditions; 2) the General Plan Consistency Section discusses noise and land use compatibility utilizing policies in the City's General Plan; and, 3) the Impacts and Mitigation Measures Section describes the significance criteria used to evaluate project impacts, provides a discussion of each project impact, and presents mitigation measures, where necessary, to provide a compatible project in relation to adjacent noise sources and land uses.

SETTING

Fundamentals of Environmental Noise

Noise may be defined as unwanted sound. Noise is usually objectionable because it is disturbing or annoying. The objectionable nature of sound could be caused by its *pitch* or its *loudness*. *Pitch* is the height or depth of a tone or sound, depending on the relative rapidity (*frequency*) of the vibrations by which it is produced. Higher pitched signals sound louder to humans than sounds with a lower pitch. *Loudness* is intensity of sound waves combined with the reception characteristics of the ear. Intensity may be compared with the height of an ocean wave in that it is a measure of the amplitude of the sound wave.

In addition to the concepts of pitch and loudness, there are several noise measurement scales which are used to describe noise in a particular location. A *decibel (dB)* is a unit of measurement which indicates the relative amplitude of a sound. The zero on the decibel scale is based on the lowest sound level that the healthy, unimpaired human ear can detect. Sound levels in decibels are calculated on a logarithmic basis. An increase of 10 decibels represents a ten-fold increase in acoustic energy, while 20 decibels is 100 times more intense, 30 decibels is 1,000 times more intense, etc. There is a relationship between the subjective noisiness or loudness of a sound and its intensity. Each 10 decibel increase in sound level is perceived as approximately a doubling of loudness over a fairly wide range of intensities. Technical terms are defined in Table 1.

There are several methods of characterizing sound. The most common in California is the *A-weighted sound level (dBA).* This scale gives greater weight to the frequencies of sound to which the human ear is most sensitive. Representative outdoor and indoor noise levels in units of dBA are shown in Table 2. Because sound levels can vary markedly over a short period of time, a method for describing either the average character of the sound or the statistical behavior of the variations must be utilized. Most commonly, environmental sounds are described in terms of an average level that has the same acoustical energy as the summation of all the time-varying events. This *energy-equivalent sound/noise descriptor* is called L_{eq}. The most common averaging period is hourly, but L_{eq} can describe any series of noise events of arbitrary duration.

The scientific instrument used to measure noise is the sound level meter. Sound level meters can accurately measure environmental noise levels to within about plus or minus 1 dBA. Various computer models are used to predict environmental noise levels from sources, such as roadways and airports. The accuracy of the predicted models depends upon the distance the receptor is from the noise source. Close to the noise source, the models are accurate to within about plus or minus 1 to 2 dBA.

Since the sensitivity to noise increases during the evening and at night -- because excessive noise interferes with the ability to sleep -- 24-hour descriptors have been developed that incorporate artificial noise penalties added to quiet-time noise events. The *Community Noise Equivalent Level* (*CNEL*) is a measure of the cumulative noise exposure in a community, with a 5 dB penalty added to evening (7:00 pm - 10:00 pm) and a 10 dB addition to nocturnal (10:00 pm - 7:00 am) noise levels. The *Day/Night Average Sound Level* (*DNL* or L_{dn}) is essentially the same as CNEL, with the exception that the evening time period is dropped and all occurrences during this three-hour period are grouped into the daytime period.

Effects of Noise

The thresholds for speech interference indoors are about 45 dBA if the noise is steady and above 55 dBA if the noise is fluctuating. Outdoors the thresholds are about 15 dBA higher. Steady noises of sufficient intensity (above 35 dBA) and fluctuating noise levels above about 45 dBA have been shown to affect sleep. Interior residential standards for multi-family dwellings are set by the State of California at 45 dBA L_{dn}. Typically, the highest steady traffic noise level during the daytime is about equal to the L_{dn} and nighttime levels are 10 dB lower. The standard is designed for sleep and speech protection and most jurisdictions apply the same criterion for all residential uses. Typical structural attenuation is 12 to 17 dB with open windows. With standard construction and closed windows in good condition, the noise attenuation factor is around 20 dB for an older structure and 25 dB for a newer dwelling. Sleep and speech interference is therefore of concern when exterior noise levels are about 57 to 62 dBA L_{dn} with open windows and 65 to 70 dBA L_{dn} if the windows are closed. Levels of 55 to 60 dBA are common along collector streets and secondary arterials, while 65 to 70 dBA is a typical value for a primary/major arterial. Levels of 75 to 80 dBA are normal noise levels at the first row of development outside a freeway right-of-way. In order to achieve an acceptable interior noise environment, bedrooms facing secondary roadways need to be able to have their windows closed, those facing major roadways and freeways typically need special glass windows.

TABLE 1 Definition of Acoustical Terms Used in this Report

Term	Definition
Decibel, dB	A unit describing, the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. The reference pressure for air is 20 micro Pascals.
Sound Pressure Level	Sound pressure is the sound force per unit area, usually expressed in micro Pascals (or 20 micro Newtons per square meter), where 1 Pascal is the pressure resulting from a force of 1 Newton exerted over an area of 1 square meter. The sound pressure level is expressed in decibels as 20 times the logarithm to the base 10 of the ratio between the pressures exerted by the sound to a reference sound pressure (e. g., 20 micro Pascals). Sound pressure level is the quantity that is directly measured by a sound level meter.
Frequency, Hz	The number of complete pressure fluctuations per second above and below atmospheric pressure. Normal human hearing is between 20 Hz and 20,000 Hz. Infrasonic sound are below 20 Hz and Ultrasonic sounds are above 20,000 Hz.
A-Weighted Sound Level, dBA	The sound pressure level in decibels as measured on a sound level meter using the A-weighting filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise.
Equivalent Noise Level, L_{eq}	The average A-weighted noise level during the measurement period.
L_{max}, L_{min}	The maximum and minimum A-weighted noise level during the measurement period.
L_{01}, L_{10}, L_{50}, L_{90}	The A-weighted noise levels that are exceeded 1%, 10%, 50%, and 90% of the time during the measurement period.
Day/Night Noise Level, DNL or L_{dn}	The average A-weighted noise level during a 24-hour day, obtained after addition of 10 decibels to levels measured in the night between 10:00 pm and 7:00 am.
Community Noise Equivalent Level, CNEL	The average A-weighted noise level during a 24-hour day, obtained after addition of 5 decibels in the evening from 7:00 pm to 10:00 pm and after addition of 10 decibels to sound levels measured in the night between 10:00 pm and 7:00 am.
Ambient Noise Level	The composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.
Intrusive	That noise which intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, and time of occurrence and tonal or informational content as well as the prevailing ambient noise level.

Source: Handbook of Acoustical Measurements and Noise Control, Harris, 1998.

TABLE 2 Typical Noise Levels in the Environment

Common Outdoor Activities	Noise Level (dBA)	Common Indoor Activities
	110 dBA	Rock band
Jet fly-over at 1,000 feet		
	100 dBA	
Gas lawn mower at 3 feet		
	90 dBA	
Diesel truck at 50 feet at 50 mph		Food blender at 3 feet
	80 dBA	Garbage disposal at 3 feet
Noisy urban area, daytime		
Gas lawn mower, 100 feet	70 dBA	Vacuum cleaner at 10 feet
Commercial area		Normal speech at 3 feet
Heavy traffic at 300 feet	60 dBA	
		Large business office
Quiet urban daytime	50 dBA	Dishwasher in next room
Quiet urban nighttime	40 dBA	Theater, large conference room
Quiet suburban nighttime		
	30 dBA	Library
Quiet rural nighttime		Bedroom at night, concert hall (background)
	20 dBA	
		Broadcast/recording studio
	10 dBA	
	0 dBA	

Source: Technical Noise Supplement (TeNS), California Department of Transportation, September 2013.

Fundamentals of Groundborne Vibration

Ground vibration consists of rapidly fluctuating motions or waves with an average motion of zero. Several different methods are typically used to quantify vibration amplitude. One method is the Peak Particle Velocity (PPV). The PPV is defined as the maximum instantaneous positive or negative peak of the vibration wave. In this report, a PPV descriptor with units of mm/sec or in/sec is used to evaluate construction generated vibration for building damage and human complaints. Table 3 displays the reactions of people and the effects on buildings that continuous or frequent intermittent vibration levels produce. The guidelines in Table 3 represent syntheses of vibration criteria for human response and potential damage to buildings resulting from construction vibration.

Construction activities can cause vibration that varies in intensity depending on several factors. The use of pile driving and vibratory compaction equipment typically generates the highest construction related groundborne vibration levels. Because of the impulsive nature of such activities, the use of the PPV descriptor has been routinely used to measure and assess groundborne vibration and almost exclusively to assess the potential of vibration to cause damage and the degree of annoyance for humans.

The two primary concerns with construction-induced vibration, the potential to damage a structure and the potential to interfere with the enjoyment of life, are evaluated against different vibration limits. Human perception to vibration varies with the individual and is a function of physical setting and the type of vibration. Persons exposed to elevated ambient vibration levels, such as people in an urban environment, may tolerate a higher vibration level.

Structural damage can be classified as cosmetic only, such as paint flaking or minimal extension of cracks in building surfaces; minor, including limited surface cracking; or major, that may threaten the structural integrity of the building. Safe vibration limits that can be applied to assess the potential for damaging a structure vary by researcher. The damage criteria presented in Table 3 include several categories for ancient, fragile, and historic structures, the types of structures most at risk to damage. Most buildings are included within the categories ranging from “Historic and some old buildings” to “Modern industrial/commercial buildings”. Construction-induced vibration that can be detrimental to the building is very rare and has only been observed in instances where the structure is at a high state of disrepair and the construction activity occurs immediately adjacent to the structure.

The annoyance levels shown in Table 3 should be interpreted with care since vibration may be found to be annoying at lower levels than those shown, depending on the level of activity or the sensitivity of the individual. To sensitive individuals, vibrations approaching the threshold of perception can be annoying. Low-level vibrations frequently cause irritating secondary vibration, such as a slight rattling of windows, doors, or stacked dishes. The rattling sound can give rise to exaggerated vibration complaints, even though there is very little risk of actual structural damage.

TABLE 3 Reaction of People and Damage to Buildings from Continuous or Frequent Intermittent Vibration Levels

Velocity Level, PPV (in/sec)	Human Reaction	Effect on Buildings
0.01	Barely perceptible	No effect
0.04	Distinctly perceptible	Vibration unlikely to cause damage of any type to any structure
0.08	Distinctly perceptible to strongly perceptible	Recommended upper level of the vibration to which ruins and ancient monuments should be subjected
0.1	Strongly perceptible	Threshold at which there is a risk of damage to fragile buildings with no risk of damage to most buildings
0.25	Strongly perceptible to severe	Threshold at which there is a risk of damage to historic and some old buildings.
0.3	Strongly perceptible to severe	Threshold at which there is a risk of damage to older residential structures
0.5	Severe - Vibrations considered unpleasant	Threshold at which there is a risk of damage to new residential and modern commercial/industrial structures

Source: Transportation and Construction Vibration Guidance Manual, California Department of Transportation, September 2013.

Regulatory Background

The State of California and the City of Los Altos have established regulatory criteria that are applicable in this assessment. The State CEQA Guidelines, Appendix G, are used to assess the potential significance of impacts pursuant to local General Plan policies, Municipal Code standards, or the applicable standards of other agencies. A summary of the applicable regulatory criteria is provided below.

State CEQA Guidelines. The California Environmental Quality Act (CEQA) contains guidelines to evaluate the significance of effects of environmental noise attributable to a proposed project. Under CEQA, noise impacts would be considered significant if the project would result in:

(a) Generation of a substantial temporary or permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies;

(b) Generation of excessive groundborne vibration or groundborne noise levels;

(c) For a project located within the vicinity of a private airstrip or an airport land use plan or where such a plan has not been adopted within two miles of a public airport or public use airport, if the project would expose people residing or working in the project area to excessive noise levels.

Checklist items (a) and (b) are applicable to the proposed project. The project is not located within two miles of a public airport or in the vicinity of a private airstrip and would not expose people

residing or working in the project area to excessive aircraft noise levels; therefore, item (c) is not carried further in this analysis.

2016 California Building Code, Title 24, Part 2. The current version of the California Building Code (CBC) requires interior noise levels attributable to exterior environmental noise sources to be limited to a level not exceeding 45 dBA L_{dn}/CNEL in any habitable room.

City of Los Altos General Plan. The Natural Environment & Hazards Element of the City of Los Altos' General Plan contains Noise and Land Use Compatibility Standards policies that are applicable to the Project. Residential land uses are considered "normally acceptable" when sites are exposed to noise levels below 60 dBA L_{dn}, "conditionally acceptable" when exposed to noise levels between 60 and 70 dBA L_{dn}, "normally unacceptable" when exposed to noise levels of between 70 and 75 dBA L_{dn} and "clearly unacceptable" when exposed to noise levels above 75 dBA L_{dn}.

City of Los Altos Municipal Code. Chapter 6.16 Noise Control of the City's Municipal Code establishes noise level limits applicable to the project as follows:

6.16.050 Exterior noise limits.
A. Maximum permissible sound levels by receiving land use.

1. The noise standards for the various categories of land use identified by the noise control office as presented in Table 4 of this section, unless otherwise specifically indicated, shall apply to all such property within a designated zone.
2. No person shall operate, or cause to be operated, any source of sound at any location within the city, or allow the creation of any noise on property owned, leased, occupied, or otherwise controlled by such person, which causes the noise level, when measured on any other property, either incorporated or unincorporated, to exceed:
    a. The noise standard for that land use as specified in Table 4 for a cumulative period of more than thirty (30) minutes in any hour (L_{50}); or
    b. The noise standard plus five dB for a cumulative period of more than fifteen (15) minutes in any hour(L_{25}); or
    c. The noise standard plus ten (10) dB for a cumulative period of more than five (5) minutes in any hour(L_{08}); or
    d. The noise standard plus fifteen (15) dB for a cumulative period of more than one minute in any hour (L_{02}); or
    e. The noise standard plus twenty (20) dB or the maximum measured ambient for any period of time (L_{max});.
3. If the measured ambient level exceeds that permissible within any of the first four noise limit categories above, the allowable noise exposure standard shall be increased in five dB increments in each category as appropriate to encompass or reflect such ambient noise level. In the event the ambient noise level exceeds the fifth noise limit category, the maximum allowable noise level under said category shall be increased to reflect the maximum ambient noise level.
4. If the noise measurement occurs on a property adjacent to a zone boundary, the noise level limit applicable to the lower noise zone, plus five dB, shall apply.

5. If possible, the ambient noise shall be measured at a consistent location on the property with the alleged offending noise source inoperative. If for any reason the alleged offending noise source cannot be shut down, the ambient noise shall be estimated by performing a measurement in the same general source at least ten (10) dB below the ambient in order that only the ambient level be measured. If the difference between the ambient and the noise source is five to ten (10) dB, then the level of the ambient itself can be reasonably determined by subtracting a one decibel correction to account for the contribution of the source.

B. Corrections for character of sound. In the event the alleged offensive noise contains a steady, audible tone, such as a whine, screech, or hum, or contains music or speech conveying informational content, the standard limits set forth in Table 4 shall be reduced by five dB.

TABLE 4: Exterior Noise Limits, L_{50}

Receiving Land Use Category	Time Period	L_{50} Noise Level (dBA)*
All R1 Zoning Districts	10:00 p.m. -- 7:00 a.m.	45
	7:00 a.m. -- 10:00 p.m.	55
All R3 and PCF Zoning Districts	10:00 p.m. -- 7:00 a.m.	50
	7:00 a.m. -- 10:00 p.m.	55
All OA Zoning Districts	10:00 p.m. -- 7:00 a.m.	55
	7:00 a.m. -- 10:00 p.m.	60
All C Zoning Districts	10:00 p.m. -- 7:00 a.m.	60
	7:00 a.m.--10:00 p.m.	65

* Levels not to be exceeded more than 30 minutes in any hour, L_{50}

6.16.060 - Interior noise standards.

A. Maximum permissible dwelling interior sound levels.
1. The interior noise standards for multi-family residential dwellings as presented in Table 5 of this section shall apply, unless otherwise specifically indicated, within all such dwellings with windows in their normal seasonal configuration.
2. No person shall operate, or cause to be operated, within a dwelling unit any source of sound or allow the creation of any noise which causes the noise level when measured inside a neighboring receiving dwelling unit to exceed:
   a. The noise standard as specified in Table 5 for a cumulative period of more than five minutes in any hour; or
   b. The noise standard plus five dB for a cumulative period of more than one minute in any hour; or
   c. The noise standard plus ten (10) dB or the maximum measured ambient for any period of time.
3. If the measured ambient level exceeds that permissible within any of the noise limit categories above, the allowable noise exposure standard shall be increased in five dB increments in each category as appropriate to reflect such ambient noise level.

B. Corrections for character of sound. In the event the alleged offensive noise contains a steady, audible tone, such as a whine, screech, or hum, or contains music or speech conveying informational content, the standard limits set forth in Table 5 shall be reduced by five dB.

TABLE 5: Interior Noise Standards

Noise Zone	Land Use	Time Interval	Allowable Interior Noise Level, dBA
All R3 Zoning Districts	Multi-Family Residential	10:00 p.m. -- 7:00 a.m.	35
		7:00 a.m.--10:00 p.m.	45

6.16.070 Prohibited acts.

A. Noise disturbances prohibited. No person shall unnecessarily make or continue, or cause to be made or continued, any noise disturbance.

B. Specific prohibitions. The following acts, and the causing or permitting thereof, are declared to be in violation of this chapter:

6. Construction and demolition.

a. i. Single-family zoning districts. Operating or causing the operation of any tools or equipment used in construction, drilling, repair, alteration, or demolition work on weekdays before 7:00 a.m. and after 5:30 p.m. and on Saturdays before 9:00 a.m. or after 3:00 p.m. or any time on Sundays or the city observed holidays of New Year's Day, Memorial Day, Independence Day, Labor Day, Veterans' Day, Thanksgiving Day and Christmas Day, such that the sound therefrom creates a noise disturbance across a residential or commercial real property line, except for emergency work of public utilities or by special exception. This section shall apply to operations on residentially zoned property only. This section shall not apply to the use of lawn or garden tools;

ii. All other zoning districts (excluding single-family districts). Operating or causing the operation of any tools or equipment used in construction, drilling, repair, alteration, or demolition work on weekdays before 7:00 a.m. and after 7:00 p.m. and Saturdays before 9:00 a.m. or after 6:00 p.m. or any time on Sundays or the city observed holidays of New Year's Day, Memorial Day, Independence Day, Labor Day, Veterans' Day, Thanksgiving Day and Christmas Day, such that the sound there from creates a noise disturbance across a residential or commercial real property line, except for emergency work of public service utilities or by special exception. This section shall apply to operations on properties other than residentially zoned property. This section shall not apply to the use of lawn or garden tools;

b. Where technically and economically feasible, construction activities shall be conducted in such a manner that the maximum noise levels at affected properties will not exceed those listed in the following schedules:

i. Mobile equipment. Maximum noise levels for the nonscheduled, intermittent, short-term operation (less than ten (10) days) of mobile equipment:

TABLE 6: Maximum Noise Levels for the nonscheduled, Intermittent, and Short–Term Operations (Less than ten (10) days) for Mobile Equipment

	All R1 Zoning Districts	All PCF and R3 Zoning Districts	All OA and C Zoning Districts
Daily, except Sundays and legal holidays 7:00 a.m. & 7:00 p.m.	75 dBA	80 dBA	85 dBA
Daily, 7:00 p.m. & 7:00 a.m. and all day Sundays and legal holidays	50 dBA	55 dBA	60 dBA

ii. Stationary equipment. Maximum noise levels for the respectively scheduled and relatively long-term operation (periods of ten (10) days or more) of stationary equipment:

TABLE 7: Maximum Noise Levels for the nonscheduled, Intermittent, and Short–Term Operations (Less than ten (10) days) for Stationary Equipment

	All R1 Zoning Districts	All PCF and R3 Zoning Districts	All OA and C Zoning Districts
Daily, except Sundays and legal holidays 7:00 a.m. & 7:00 p.m.	75 dBA	80 dBA	85 dBA
Daily, 7:00 p.m. & 7:00 a.m. and all day Sundays and legal holidays	50 dBA	55 dBA	60 dBA

c. Deliveries, start-up and closing down. The construction times above shall apply to deliveries of materials and equipment, and arrival of workers, start-up and closing down and departure activities on a job site.

12. Air-conditioning or air-handling equipment. Operating or permitting the operation of any air-conditioning or air-handling equipment in such a manner as to exceed any of the following sound levels without a variance:

TABLE 8: Air-Conditioning or Air-Handling Equipment Operational Sound Levels

Measurement Location	Residentially zoned properties, dB(A)
Any point on a neighboring property line, five feet above grade level, no closer than three feet from any wall	50
Center of a neighboring patio, five feet above grade level, no closer than three feet from any wall	45
Outside the neighboring living area window nearest the equipment location, not more than three feet from the window opening, but at least three feet from any other surface	45

Existing Noise Environment

The project is located at 5150 El Camino Real in Los Altos, California. The site is currently occupied by an existing office building and associated parking lot. Residential and commercial uses surround the site. A noise monitoring survey was performed to quantify and characterize noise levels at the site and in the project vicinity between Tuesday, January 22nd, 2019 and Friday, January 25th, 2019. The monitoring survey included two long-term noise measurements (LT-1 and LT-2) and three short-term noise measurements (ST-1, ST-2, and ST-3). The primary noise source at the site and in the vicinity is vehicular traffic on El Camino Real. Noise monitoring locations are depicted in Figure 1. The daily trends in noise levels at LT-1 and LT-2 are shown in Appendix A.

Long-term noise measurement LT-1 was made at the southwest corner of the project site, about 330 feet from the center of El Camino Real. Hourly average noise levels at this location, generated primarily from vehicular traffic on El Camino Real, typically ranged from 53 to 60 dBA L_{eq} during the day and from 46 to 57 dBA L_{eq} at night. The day-night average noise level at LT-1 was 59 dBA L_{dn}.

Long-term noise measurement LT-2 was made in front of 4906 El Camino Real, about 50 feet from the center of El Camino Real. This location was selected to quantify noise levels generated by traffic along El Camino Real. Long-term monitoring along El Camino Real at the project site was avoided due to local construction activity, which affected the noise environment. Hourly average noise levels at this location ranged from 71 to 75 dBA L_{eq} during the day and from 61 to 72 dBA L_{eq} at night. The day-night average noise level at LT-2 was 75 dBA L_{dn}.

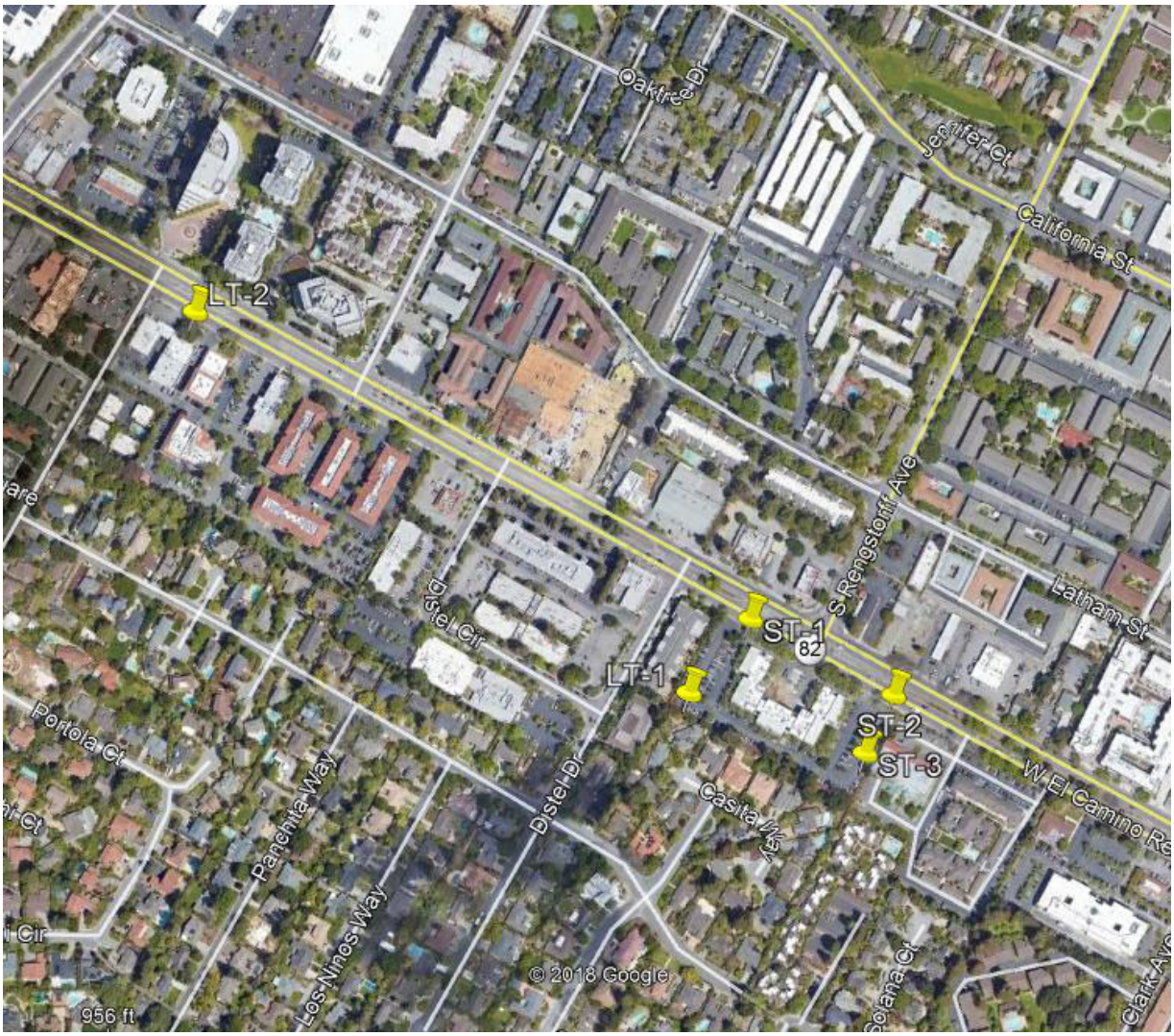
Short-term measurement locations were selected to quantify ambient noise levels throughout the site. ST-1 was made at the front of 5150 El Camino Real, at a distance of about 45 feet from the edge of El Camino Real. The 10-minute average noise level measured at this location was 70 dBA L_{eq}. Short-term noise measurement ST-2 was made in the parking lot to the southeast of the existing on-site building, approximately 30 feet from the edge of El Camino Real. The 10-minute average noise level measured at this location was 73 dBA L_{eq}. Measurement ST-3 was made in the southeastern portion of the site and resulted in a 10-minute average noise level of 55 dBA L_{eq}. Table 9 summarizes the results of the short-term measurements.

TABLE 9 Summary of Short-Term Noise Measurement Data (dBA), January 22nd, 2019

Noise Measurement Location	$L_{(1)}$	$L_{(10)}$	$L_{(50)}$	$L_{(90)}$	L_{eq}	Calculated L_{dn}[1]
ST-1: 45 feet from edge of El Camino Real (2:10 p.m. - 2:20 p.m.)	76	73	69	60	70	71
ST-2: 30 feet from edge of El Camino Real (3:20 p.m. - 3:30 p.m.)	79	75	71	61	73	74
ST-3: Southeast corner of site (3:50 p.m. – 4:00 p.m.)	60	58	55	49	55	59

[1] Based on comparison of short-term and long-term noise monitoring results.

FIGURE 1 Noise Measurement Locations



Source: Google Earth

GENERAL PLAN CONSISTENCY ANALYSIS

The impacts of site constraints such as exposure of the proposed project to excessive levels of noise and vibration are not considered under CEQA. This section addresses Noise and Land Use Compatibility for consistency with the policies set forth in the City's General Plan.

Noise and Land Use Compatibility

The applicable Los Altos General Plan policies were presented in detail in the Regulatory Background section and are summarized below for the proposed project:

- The City's acceptable exterior noise level objective is 60 dBA L_{dn} or less for residences.
- The City's standard for interior noise levels in residences is 45 dBA L_{dn}.

Future Exterior Noise Environment

The primary source of noise affecting the project site will continue to be vehicular traffic on El Camino Real. Based on traffic volumes provided in the Traffic Impact Study[1], future traffic noise levels along El Camino Real with the project are anticipated to increase by less than 1 dBA over existing levels. Traffic noise increases along El Camino Real are estimated to result in a future noise increase of 1 dBA L_{dn} above existing conditions with the build out of the General Plan, assuming a 1% to 2% increase in traffic volumes per year over the next 20 years.

Outdoor use areas include various amenities for residents, including a pool, play area, bocce ball court, club house, outdoor grill area, residential lobbies and open space courtyards in the interior of the site. Noise levels in these areas, which are setback and well shielded from El Camino Real from project structures, would be below 60 dBA L_{dn} and would be considered "normally acceptable" by the City of Los Altos.

Trellised seating areas provided at the condominium buildings' frontages on El Camino Real would be exposed to noise levels as high as 75 dBA L_{dn}. It is not acoustically feasible to reduce exterior noise levels in these seating areas to meet the City's 60 dBA L_{dn} exterior noise level objective. Alternate noise reduction strategies that would reduce day-night average noise levels to 60 dBA L_{dn} or less include fully enclosing the outdoor use areas or redesigning the site plan to locate the outdoor use areas within the interior of the project building. This strategy allows the building itself to provide acoustical shielding from traffic noise to the outdoor areas.

Future Interior Noise Environment

Residential façades of the condominium building would be located as close as 30 feet from the edge of El Camino Real. At this distance, the future exterior traffic noise exposure would be 75 dBA L_{dn}. Southwest facing façades and townhome façades would be setback and well shielded from El Camino Real and would be exposed to exterior noise levels below 60 dBA L_{dn}.

[1] 5150 El Camino Real Residential Development, Traffic Impact Study, Hexagon Transportation Consultants, Inc., January 3, 2019.

Interior noise levels would vary depending upon the design of the buildings (relative window area to wall area) and the selected construction materials and methods. Standard residential construction provides approximately 15 dBA of exterior-to-interior noise reduction, assuming the windows are partially open for ventilation. Standard construction with the windows closed provides approximately 20 to 25 dBA of noise reduction in interior spaces. Where exterior noise levels are 60 dBA L_{dn}, or less interior noise levels would be considered acceptable levels with standard construction and windows in the open or closed position. Where exterior noise levels range from 60 to 70 dBA L_{dn}, the inclusion of adequate forced-air mechanical ventilation can reduce interior noise levels to acceptable levels by allowing occupants the option of closing the windows to control noise. In noise environments of 70 dBA L_{dn} or greater, a combination of forced-air mechanical ventilation and sound-rated construction methods is often required to meet the interior noise level limit. Such methods or materials may include a combination of smaller window and door sizes as a percentage of the total building façade facing the noise source, sound-rated windows and doors, sound-rated exterior wall assemblies, and mechanical ventilation so windows may be kept closed at the occupant's discretion.

The minimum STC ratings required to achieve the 45 dBA L_{dn} threshold are summarized in Figure 2. Based on preliminary calculations, residential units fronting El Camino Real would achieve the 45 dBA L_{dn} interior standard with the inclusion of forced-air mechanical ventilation, three-coat (7/8" thick) stucco wall construction (STC 46 or greater), and windows and exterior doors with STC[2] ratings of 33 to 34 or with wood siding (STC 39 or greater) and windows and doors with STC ratings of 36 to 38 (identified in Figure 2 as Type 1). Northwest and southeast facing units would achieve the interior standard with the inclusion of forced-air mechanical ventilation and windows and doors with STC ratings of 28 to 29 or higher (identified in Figure 2 as Type 2). Southwest facing condo units and all townhome units would achieve the 45 dBA L_{dn} interior standard with standard construction and the inclusion of forced-air mechanical ventilation to allow occupants the option of keeping windows closed to control noise. The analysis assumes that the façade area is made up of 40% windows or less. Where STC rated windows are recommended, windows are assumed to be in the closed position, requiring forced-air ventilation to allow occupants the option of keeping windows closed.

Recommended Conditions of Approval

For consistency with the General Plan, the following Conditions of Approval are recommended for consideration by the City:

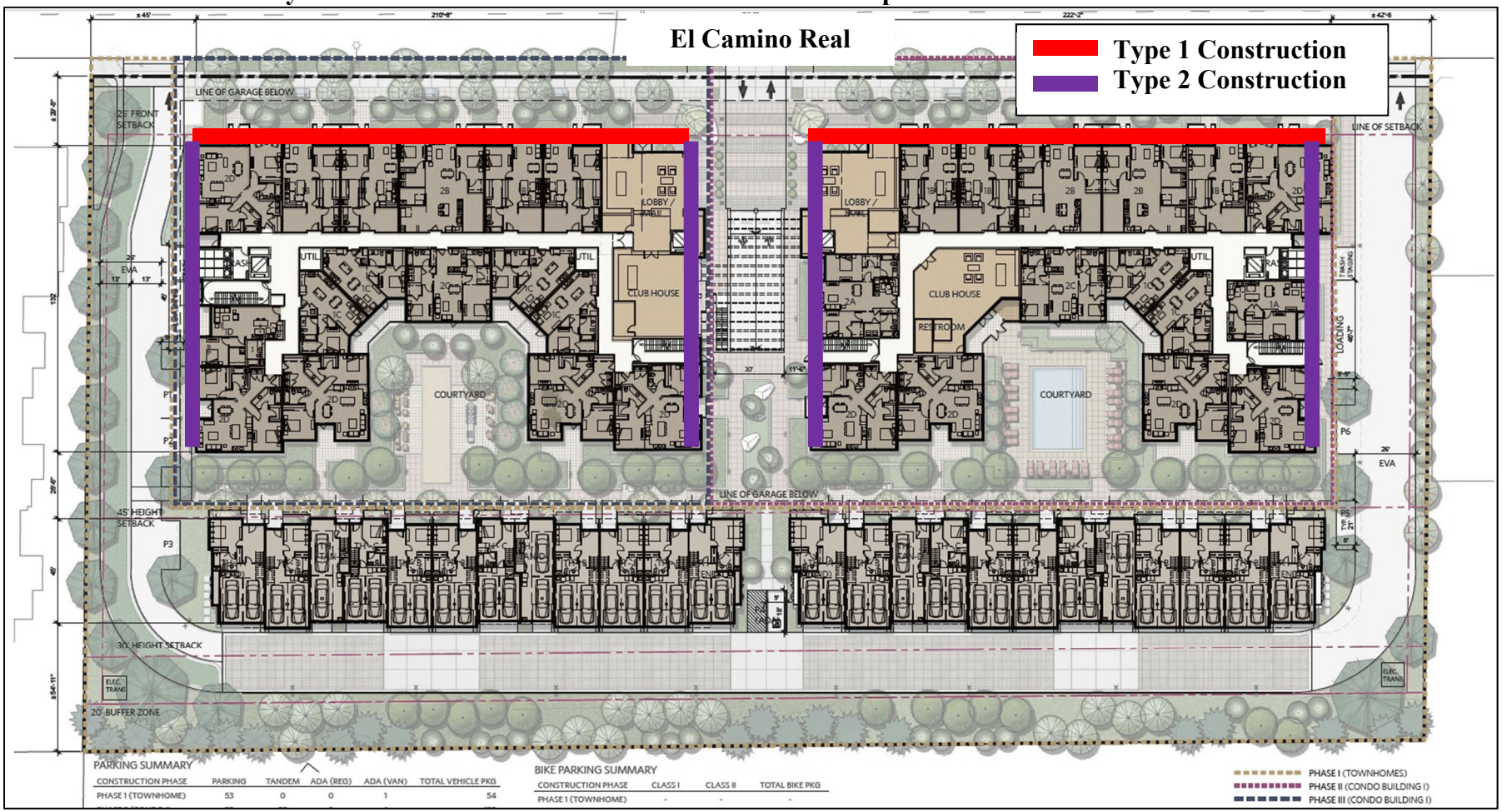
- When refining the project's site plan, locate outdoor use areas away from El Camino Real and continue to shield noise-sensitive outdoor spaces with buildings or noise barriers where feasible.

[2] **Sound Transmission Class (STC)** A single figure rating designed to give an estimate of the sound insulation properties of a partition. Numerically, STC represents the number of decibels of speech sound reduction from one side of the partition to the other. The STC is intended for use when speech and office noise constitute the principal noise problem.

- Provide a suitable form of forced-air mechanical ventilation, as determined by the local building official, for all residential buildings, so that windows can be kept closed to control noise.

- Provide sound rated windows to northeast, northwest, and southeast facing condo units to maintain interior noise levels at acceptable levels. Preliminary calculations show that sound-rated windows with minimum STC Rating of 33 to 34 would be satisfactory for units fronting El Camino Real and windows with minimum STC Rating of 28 to 29 would be satisfactory for northwest and southeast facing condominium units to achieve acceptable interior noise levels, assuming a wall construction with STC 46 or greater and 40% windows or less. The specific determination of what noise insulation treatments are necessary shall be conducted on a unit-by-unit basis during final design of the project once final building plans and elevations are available.

FIGURE 2 Preliminary Recommendation to Reduce Interior Noise to Acceptable Levels



NOISE IMPACTS AND MITIGATION MEASURES

This section describes the significance criteria used to evaluate project impacts under CEQA, provides a discussion of each project impact, and presents mitigation measures, where necessary, to provide a compatible project in relation to adjacent noise sources and land uses.

Significance Criteria

The following criteria were used to evaluate the significance of environmental noise and vibration resulting from the project:

1. **Temporary or Permanent Noise Increases in Excess of Established Standards.** A significant impact would be identified if project construction or operations would result in a substantial temporary or permanent increase in ambient noise levels at sensitive receivers in excess of the local noise standards contained in the Los Altos General Plan or Municipal Code, as follows:

    - Operational Noise in Excess of Standards. A significant noise impact would be identified if the project would expose persons to or generate noise levels that would exceed applicable noise standards presented in the General Plan or Municipal Code. The City of Los Altos limits sound levels generated by air-conditioning or air-handling equipment to 50 dBA at residential property lines and 45 dBA at residential patios and building façades. Other operational noise sources are limits to the levels specified in Table 4.

    - Permanent Noise Increase. A significant impact would be identified if traffic or school activity noise generated by the project would substantially increase noise levels at sensitive receivers in the vicinity. A substantial increase would occur if: a) the noise level increase is 5 dBA L_{dn} or greater, with a future noise level of less than 60 dBA L_{dn}, or b) the noise level increase is 3 dBA L_{dn} or greater, with a future noise level of 60 dBA L_{dn} or greater.

    - Temporary Noise Increase. A significant temporary noise impact would be identified if construction would occur outside of the hours specified in the Municipal Code or if construction noise levels were to exceed the City's construction noise limits at adjacent noise sensitive land uses. Construction occurring during allowable hours is limited to 75 dBA in single-family residential areas, 80 dBA in multi-family residential areas, and 85 dBA in commercial areas.

2. **Generation of Excessive Groundborne Vibration.** A significant impact would be identified if the construction of the project would generate excessive vibration levels. Groundborne vibration levels exceeding 0.3 in/sec PPV would be considered excessive as such levels would have the potential to result in cosmetic damage to buildings.

Impact 1: **Temporary or Permanent Noise Increases in Excess of Established Standards.** Project traffic would not result in a substantial permanent noise level increase at existing noise-sensitive land uses in the project vicinity. However, existing noise-sensitive land uses could be exposed to operational and construction noise levels in excess of the applicable noise thresholds. **This is a potentially significant impact.**

Permanent Noise Increases from On-Site Operational Noise

The City of Los Altos limits sound levels generated by air-conditioning or air-handling equipment to 50 dBA at residential property lines and 45 dBA at residential patios and building façades. The descriptor for the noise limit is not specified. For consistency with the provisions of the code, a reasonable interpretation of this standard would identify the criteria as an hourly average L_{eq}. Other operational noise sources are limits to the levels specified in Table 4.

Parking

The majority of parking would be provided in the underground garage. Parking activities occurring in the underground garage would not be anticipated to be audible outside of the parking structure. Noise associated with on-site circulation and parking for the townhomes would be similar to levels generated by use of the current parking lot and below noise levels generated by vehicular traffic traveling along El Camino Real and those specified in Table 4. This is a **less-than-significant** impact.

Mechanical Equipment

The proposed project would include mechanical equipment such as heating, ventilation, and air conditioning systems (HVAC) in an enclosed room within the underground garage. The buildings' condenser, exhaust fans, and boilers would be located on the rooftop. The most substantial noise-generating mechanical equipment proposed for the project is anticipated to be exhaust fans and building air conditioning units. Equipment, such as the air conditioning units, located inside or in a fully enclosed room with a roof would not be anticipated to be audible at off-site locations. Typical residential rooftop exhaust fans are anticipated to generate noise levels of 50 to 60 dBA at 50 feet from the equipment, depending on the equipment selected. Shielding from equipment enclosures and surrounding structures would provide 10 to 15 dBA of reduction.

Existing residences are located as close as about 80 feet from the closest proposed project buildings. Assuming a credible worst-case scenario with unshielded equipment placed in the center of the townhome building that is nearest to residences to the southwest, exhaust fan noise could reach noise levels as high as 45 to 55 dBA L_{eq} at residences to the southwest and would exceed the 50 dBA L_{eq} limit at the property line. Mechanical equipment located 150 feet or further from residential property lines or in shielded areas would be anticipated to meet the 50 dBA L_{eq} limit. This is a **potentially significant** impact.

Mitigation Measure 1a: The following mitigation measures would reduce this impact to a less-than-significant level.

Prior to the issuance of building permits, mechanical equipment shall be selected and designed to reduce impacts on surrounding uses to meet the City's requirements. A qualified acoustical

consultant shall be retained by the project applicant to review mechanical noise as the equipment systems are selected in order to determine specific noise reduction measures necessary to reduce noise to comply with the City's 50 dBA L_{eq} residential noise limit at the shared property lines. Noise reduction measures could include, but are not limited to, selection of equipment that emits low noise levels and/or installation of noise barriers such as enclosures and parapet walls to block the line of sight between the noise source and the nearest receptors.

Permanent Noise Increases from Project Traffic

Neither the City of Los Altos nor the State of California define the traffic noise level increase that is considered substantial. A significant impact would typically be identified if project generated traffic were to result in a permanent noise level increase of 3 dBA L_{dn} or greater in a residential area where the resulting noise environment would exceed or continue to exceed 60 dBA L_{dn} or result in a permanent noise increase of 5 dBA L_{dn} or greater in a residential area where the resulting in a noise environment would continue to be 60 dBA L_{dn} or less. For reference, a 3 dBA L_{dn} noise increase would be expected if the project would double existing traffic volumes along a roadway.

The Traffic Impact Analysis provided by Hexagon Transportation Consultants, Inc[3] was reviewed to calculate potential traffic noise level increases attributable to the project. Traffic volumes were provided for El Camino Real, Rengstorff Avenue, Distel Road, and Clark Avenue. To determine the project-generated traffic noise increase, peak hour volumes for the Existing scenario are compared to Existing plus Project conditions. Based on this comparison, traffic noise levels are calculated to increase by less than 1 dBA L_{eq} along the roadway network in the project vicinity during peak hour traffic conditions.

Traffic noise increases resulting from the proposed project would not result in noise increases of 3 dBA L_{dn} or more on the surrounding roadway network. This is a **less-than-significant** impact.

Temporary Noise Increases from Project Construction

Chapter 6.16.070 of the City's Municipal Code establishes allowable hours of construction within residentially zoned properties between 7:00 a.m. and 5:30 p.m. Monday through Friday and between 9:00 a.m. and 3:00 p.m. on Saturdays. Construction in all other zoning districts (excluding single-family districts) is permissible between 7:00 a.m. and 7:00 p.m. Monday through Friday and 9:00 a.m. and 6:00 p.m. on Saturdays. Construction activities are not permitted on Sundays or the City observed holidays of New Year's Day, Memorial Day, Independence Day, Labor Day, Veterans' Day, Thanksgiving Day and Christmas Day. In addition, where technically and economically feasible, maximum noise levels from construction activities should not exceed those listed in Tables 3 and 4 in Chapter 6.16.070 of the City's Municipal Code.

The City also provides recommended maximum noise level limits for construction activities occurring over a period of less than 10 days but does not provide limits for longer duration construction. This analysis applies the noise limits to project construction, given that construction would occur for a period greater than 10 days. Construction occurring during allowable hours is

3 Traffic Impact Analysis, 5150 El Camino Real Residential, Los Altos, CA, Hexagon Transportation Consultants, Inc., January 3, 2019.

limited to 75 dBA in single-family residential areas, 80 dBA in multi-family residential areas, and 85 dBA in commercial areas. This code is not explicit in terms of the acoustical descriptor associated with the noise level limit. A reasonable interpretation of this standard would identify the criteria as an hourly average L_{eq}.

Construction of the proposed project is estimated to take 29 months and would include demolition of existing structures and pavement, site preparation, grading and excavation, trenching and foundations, building erection, and paving. Construction is anticipated to occur in three phases, beginning in 2021. Phase I would construct the at-grade, three-story townhomes at the southern end (rear) of the project site. Phase II would construct the five-story condominium building on the northeastern end of the project site, and the northeastern half of the below-ground parking garage. Phase III would construct the final five-story condominium building at the northwestern end of the site and the northwestern half of the parking garage. Pile driving is not anticipated as a method of construction.

Noise impacts resulting from construction depend upon the noise generated by various pieces of construction equipment, the timing and duration of noise-generating activities, and the distance between construction noise sources and noise-sensitive areas. Construction noise impacts primarily result when construction activities occur during noise-sensitive times of the day (e.g., early morning, evening, or nighttime hours), the construction occurs in areas immediately adjoining noise-sensitive land uses, or when construction lasts over extended periods of time.

Construction activities would be carried out in stages. During each stage of construction, there would be a different mix of equipment operating, and noise levels would vary by stage and vary within stages, based on the amount of equipment in operation and the location at which the equipment is operating. Typical construction noise levels at a distance of 50 feet are shown in Tables 10 and 11. Table 10 shows the average noise level ranges, by construction phase and Table 11 shows the maximum noise level ranges for different construction equipment. Most demolition and construction noise falls with the range of 80 to 90 dBA at 50 feet from the source. Construction-generated noise levels drop off at a rate of about 6 dBA per doubling of the distance between the source and receptor. Shielding by buildings or terrain can provide an additional 5 to 10 dBA noise reduction at distant receptors.

As shown in Tables 10 and 11, construction activities generate considerable amounts of noise, especially during demolition and earth-moving activities when heavy equipment is used. Project construction would occur within 15 feet of adjoining commercial and residential property to the southwest, southeast, and northwest. Commercial uses are also located about 200 feet to the northeast, across El Camino Real. Construction noise levels would be anticipated to exceed the single family residential limit of 75 dBA when heavy construction is located within about 150 feet of the shared southwestern property line, to exceed the multi-family residential limit of 80 dBA when heavy construction is located within about 90 feet of the shared northwestern property line, and to exceed the commercial limit of 85 dBA when heavy construction is located within about 50 feet of the shared southeastern property line. Construction noise is not anticipated to exceed 85 dBA L_{eq} at commercial property to the northeast.

TABLE 10 Typical Ranges of Construction Noise Levels at 50 Feet, L_{eq} (dBA)

	Domestic Housing		Office Building, Hotel, Hospital, School, Public Works		Industrial Parking Garage, Religious Amusement & Recreations, Store, Service Station		Public Works Roads & Highways, Sewers, and Trenches	
	I	II	I	II	I	II	I	II
Ground Clearing	83	83	84	84	84	83	84	84
Excavation	88	75	89	79	89	71	88	78
Foundations	81	81	78	78	77	77	88	88
Erection	81	65	87	75	84	72	79	78
Finishing	88	72	89	75	89	74	84	84

I - All pertinent equipment present at site.
II - Minimum required equipment present at site.

Source: U.S.E.P.A., Legal Compilation on Noise, Vol. 1, p. 2-104, 1973.

TABLE 11 Construction Equipment 50-foot Noise Emission Limits

Equipment Category	L_{max} Level (dBA)1,2	Impact/Continuous
Arc Welder	73	Continuous
Auger Drill Rig	85	Continuous
Backhoe	80	Continuous
Bar Bender	80	Continuous
Boring Jack Power Unit	80	Continuous
Chain Saw	85	Continuous
Compressor[3]	70	Continuous
Compressor (other)	80	Continuous
Concrete Mixer	85	Continuous
Concrete Pump	82	Continuous
Concrete Saw	90	Continuous
Concrete Vibrator	80	Continuous
Crane	85	Continuous
Dozer	85	Continuous
Excavator	85	Continuous
Front End Loader	80	Continuous
Generator	82	Continuous
Generator (25 KVA or less)	70	Continuous
Gradall	85	Continuous
Grader	85	Continuous
Grinder Saw	85	Continuous
Horizontal Boring Hydro Jack	80	Continuous
Hydra Break Ram	90	Impact
Impact Pile Driver	105	Impact
Insitu Soil Sampling Rig	84	Continuous
Jackhammer	85	Impact
Mounted Impact Hammer (hoe ram)	90	Impact
Paver	85	Continuous
Pneumatic Tools	85	Continuous
Pumps	77	Continuous
Rock Drill	85	Continuous
Scraper	85	Continuous
Slurry Trenching Machine	82	Continuous
Soil Mix Drill Rig	80	Continuous
Street Sweeper	80	Continuous
Tractor	84	Continuous
Truck (dump, delivery)	84	Continuous
Vacuum Excavator Truck (vac-truck)	85	Continuous
Vibratory Compactor	80	Continuous
Vibratory Pile Driver	95	Continuous
All other equipment with engines larger than 5 HP	85	Continuous

Notes:

1 Measured at 50 feet from the construction equipment, with a "slow" (1 sec.) time constant.

2 Noise limits apply to total noise emitted from equipment and associated components operating at full power while engaged in its intended operation.

3 Portable Air Compressor rated at 75 cfm or greater and that operates at greater than 50 psi.

Source: Mitigation of Nighttime Construction Noise, Vibrations and Other Nuisances, National Cooperative Highway Research Program, 1999.

Construction would be in compliance with City of Los Altos' Municipal Code specified hours of construction, but would be anticipated to exceed the construction noise limits during some periods of construction when heavy construction is located adjacent to shared property lines. This is a **potentially significant** temporary impact.

Mitigation Measure 1b: Modification, placement, and operation of construction equipment are possible means for minimizing the impact of construction noise on existing sensitive receptors. Construction equipment should be well-maintained and used judiciously to be as quiet as possible. Additionally, construction activities for the proposed project should include the following best management practices to reduce noise from construction activities near sensitive land uses:

- Construction activities shall be limited to the hours between 7:00 a.m. and 5:30 p.m., Monday through Friday, and on Saturdays between 9:00 a.m. and 3:00 p.m., in accordance with the City's Municipal Code. Construction is prohibited on Sundays and holidays, unless permission is granted with a development permit or other planning approval.

- Use of the concrete saw within 50 feet of shared property lines shall be limited, as feasible.

- Equip all internal combustion engine-driven equipment with intake and exhaust mufflers that are in good condition and appropriate for the equipment.

- Unnecessary idling of internal combustion engines should be strictly prohibited.

- Locate stationary noise-generating equipment, such as air compressors or portable power generators, as far as possible from sensitive receptors. If they must be located near receptors, adequate muffling (with enclosures where feasible and appropriate) shall be used reduce noise levels at the adjacent sensitive receptors. Any enclosure openings or venting shall face away from sensitive receptors.

- Utilize "quiet" air compressors and other stationary noise sources where technology exists.

- A temporary noise control blanket barrier could be erected, if necessary, along building facades facing construction sites. This mitigation would only be necessary if conflicts occurred which were irresolvable by proper scheduling. Noise control blanket barriers can be rented and quickly erected.

- Control noise from construction workers' radios to a point where they are not audible at existing residences bordering the project site.

- The contractor shall prepare a detailed construction plan identifying the schedule for major noise-generating construction activities. The construction plan shall identify a procedure for coordination with adjacent residential land uses so that construction activities can be scheduled to minimize noise disturbance.

- Designate a "disturbance coordinator" who would be responsible for responding to any complaints about construction noise. The disturbance coordinator will determine the cause of the noise complaint (e.g., bad muffler, etc.) and will require that reasonable measures be

implemented to correct the problem. Conspicuously post a telephone number for the disturbance coordinator at the construction site and include in it the notice sent to neighbors regarding the construction schedule.

Implementation of the above best management practices would reduce construction noise levels emanating from the site, limit construction hours, and minimize disruption and annoyance. With the implementation of these measures and recognizing that noise generated by construction activities would occur over a temporary period, the impact would be **less-than-significant**.

Impact 2: **Generation of Excessive Groundborne Vibration due to Construction.** Construction-related vibration levels could exceed 0.3 in/sec PPV at the nearest structures. **This is a potentially significant impact.**

The City of Los Altos does not specify a construction vibration limit. For structural damage, the California Department of Transportation recommends a vibration limit of 0.5 in/sec PPV for buildings structurally sound and designed to modern engineering standards, 0.3 in/sec PPV for buildings that are found to be structurally sound but where structural damage is a major concern, and a conservative limit of 0.25 in/sec PPV for historic and some old buildings (see Table 3). The 0.3 in/sec PPV vibration limit would be applicable to properties in the vicinity of the project site.

The construction of the project may generate perceptible vibration when heavy equipment or impact tools (e.g. jackhammers, hoe rams) are used. Construction would occur in three phases over a period of 2.5 years. Construction activities would include demolition, site preparation, grading and excavation, trenching and foundation, building (exterior), interior/ architectural coating and paving. Pile driving is not anticipated for construction of the building foundation.

Table 12 presents typical vibration levels from construction equipment at 25 feet. Jackhammers typically generate vibration levels of 0.035 in/sec PPV and drilling typically generates vibration levels of 0.09 in/sec PPV at 25 feet. Vibration levels would vary depending on soil conditions, construction methods, and equipment used. Table 12 also presents construction vibration levels at various distances from the construction equipment. Calculations were made to estimate vibration levels at distances of 15 feet from construction, as well as distances of 35 and 60 feet from the site to represent other nearby buildings. Vibration levels are highest close to the source, and then attenuate with increasing distance at the rate $(D_{ref}/D)^{1.1}$, where D is the distance from the source in feet and D_{ref} is the reference distance of 25 feet.

TABLE 12 Vibration Levels for Construction Equipment at Various Distances

Equipment		PPV at 15 ft. (in/sec)	PPV at 25 ft. (in/sec)	PPV at 35 ft. (in/sec)	PPV at 60 ft. (in/sec)
Clam shovel drop		**0.354**	0.202	0.140	0.077
Hydromill (slurry wall)	in soil	0.014	0.003	0.006	0.002
	in rock	0.030	0.006	0.012	0.004
Vibratory Roller		**0.368**	0.210	0.145	0.080
Hoe Ram		0.156	0.089	0.061	0.034
Large bulldozer		0.156	0.089	0.061	0.034
Caisson drilling		0.156	0.089	0.061	0.034
Loaded trucks		0.133	0.076	0.052	0.029
Jackhammer		0.061	0.035	0.024	0.013
Small bulldozer		0.005	0.003	0.002	0.001

Source: Transit Noise and Vibration Impact Assessment, United States Department of Transportation, Office of Planning and Environment, Federal Transit Administration, October 2018 as modified by Illingworth & Rodkin, Inc., January 2019.

Project construction activities, such as drilling, the use of jackhammers, rock drills and other high-power or vibratory tools, and rolling stock equipment (tracked vehicles, compactors, etc.) may generate substantial vibration in the immediate vicinity of construction activities. The closest structures to the project site include a commercial building adjoining the site to the southeast, and residential buildings adjoining the site to the southwest and northwest. Commercial structures are also located about 200 feet to the northeast, across El Camino Real.

As indicated in Table 12, heavy vibration generating construction equipment, such as vibratory rollers or clam shovel drops, would have the potential to produce vibration levels of 0.3 in/sec PPV or more within 20 feet of construction. Only one structure is located within 20 feet of the project site, a commercial building that is setback from the shared southeastern property line by about 15 feet. Heavy construction located within 5 feet of the shared property line would have the potential to exceed the 0.3 in/sec PPV threshold for buildings that are found to be structurally sound but where structural damage is a major concern. Vibration levels at all other buildings in the vicinity are calculated to be below the 0.3 in/sec PPV threshold and would not be anticipated to be impacted by project construction generated vibration.

The US Bureau of Mines has analyzed the effects of blast-induced vibration on buildings in USBM RI 85074, and these findings have been applied to vibrations emanating from construction equipment on buildings[5]. Figure 3 presents the damage probability as reported in USBM RI 8507 and reproduced by Dowding assuming a maximum vibration level of 0.4 in/sec PPV, , the maximum vibration level that would be anticipated when construction is located 15 feet from structures. As shown on Figure 3, these studies indicate no observations of "threshold damage" (referred to as cosmetic damage elsewhere in this report), "minor damage", or "major damage" at vibration levels of 0.4 in/sec PPV or less.

4 Siskind, D.E., M.S. Stagg, J.W. Kopp, and C.H. Dowding, Structure Response and Damage Produced by Ground Vibration form Surface Mine Blasting, RI 8507, Bureau of Mines Report of Investigations, U.S. Department of the Interior Bureau of Mines, Washington, D.C., 1980.

5 Dowding, C.H., Construction Vibrations, Prentice Hall, Upper Saddle River, 1996.

In summary, the construction of the project would generate vibration levels exceeding the threshold of 0.3 in/sec PPV at the adjoining commercial structure to the southeast when construction is located within 5 feet of the shared property line. Such vibration levels would be unlikely to cause cosmetic, major, or minor structural damage, but are conservatively identified as significant to provide the ultimate level of protection from construction vibration. Project-generated vibration levels would fall below the 0.3 in/sec PPV threshold at structures located 20 feet or further from construction. This is a **potentially significant** impact.

Mitigation Measure 2: Implementation of the following measures would reduce the vibration impact to a less-than-significant level at adjoining structures to the south of the project:

- A construction vibration-monitoring plan shall be implemented to document conditions at all structures located within 20 feet of proposed construction prior to, during, and after vibration generating construction activities. All plan tasks shall be undertaken under the direction of a licensed Professional Structural Engineer in the State of California and be in accordance with industry accepted standard methods. The construction vibration monitoring plan should be implemented to include the following tasks:

    - Identification of sensitivity to groundborne vibration of all structures located within 20 feet of construction.

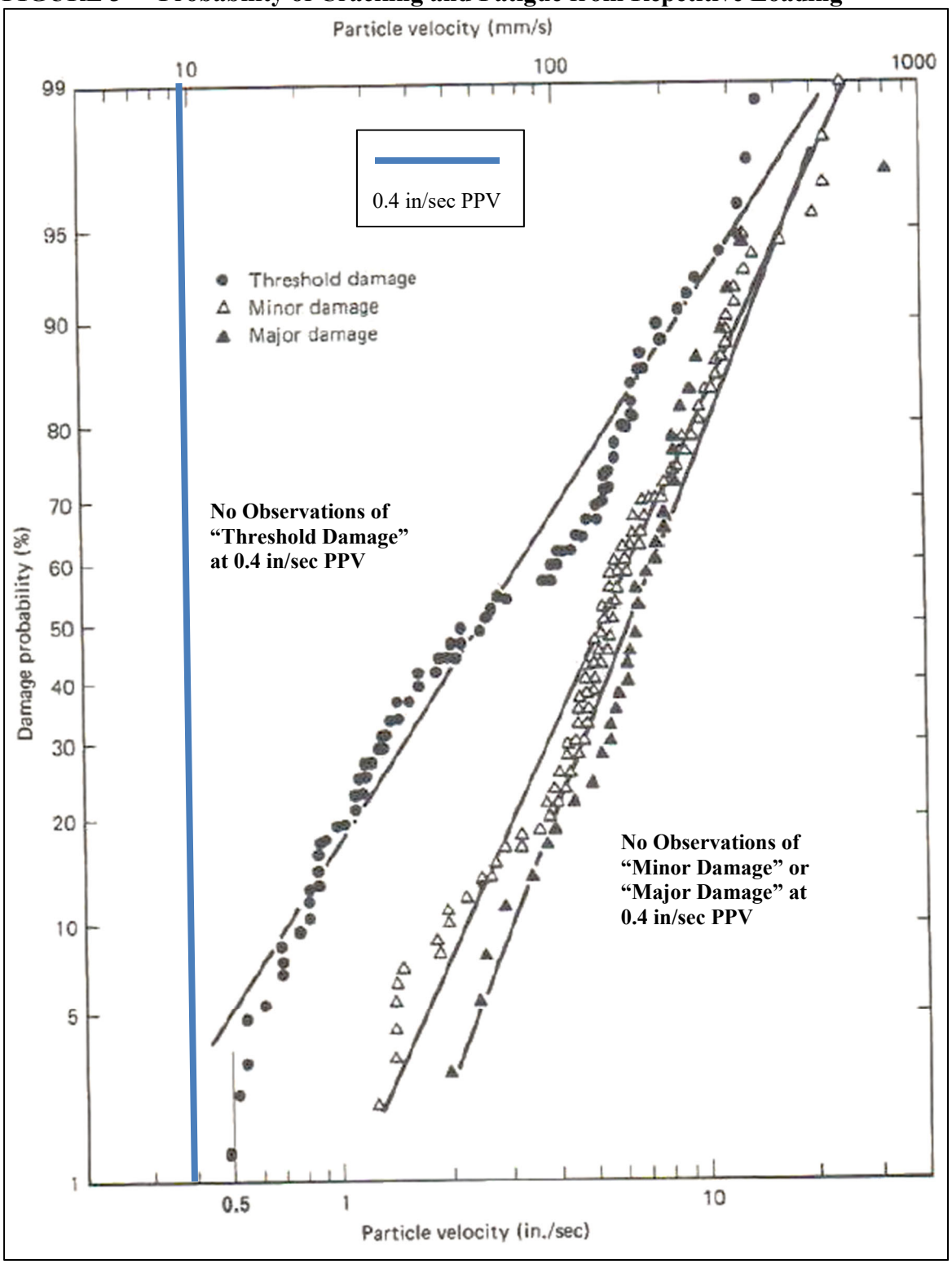
    - Performance of a photo survey, elevation survey, and crack monitoring survey for all structures located within 20 feet of construction. Surveys shall be performed prior to, in regular intervals during, and after completion of vibration generating construction activities and shall include internal and external crack monitoring in the structure, settlement, and distress and shall document the condition of the foundation, walls and other structural elements in the interior and exterior of said structure.

    - Conduct a post-survey on the structure where either monitoring has indicated high levels or complaints of damage. Make appropriate repairs or provide compensation where damage has occurred as a result of construction activities.

    - Designate a person responsible for registering and investigating claims of excessive vibration. The contact information of such person shall be clearly posted on the construction site.

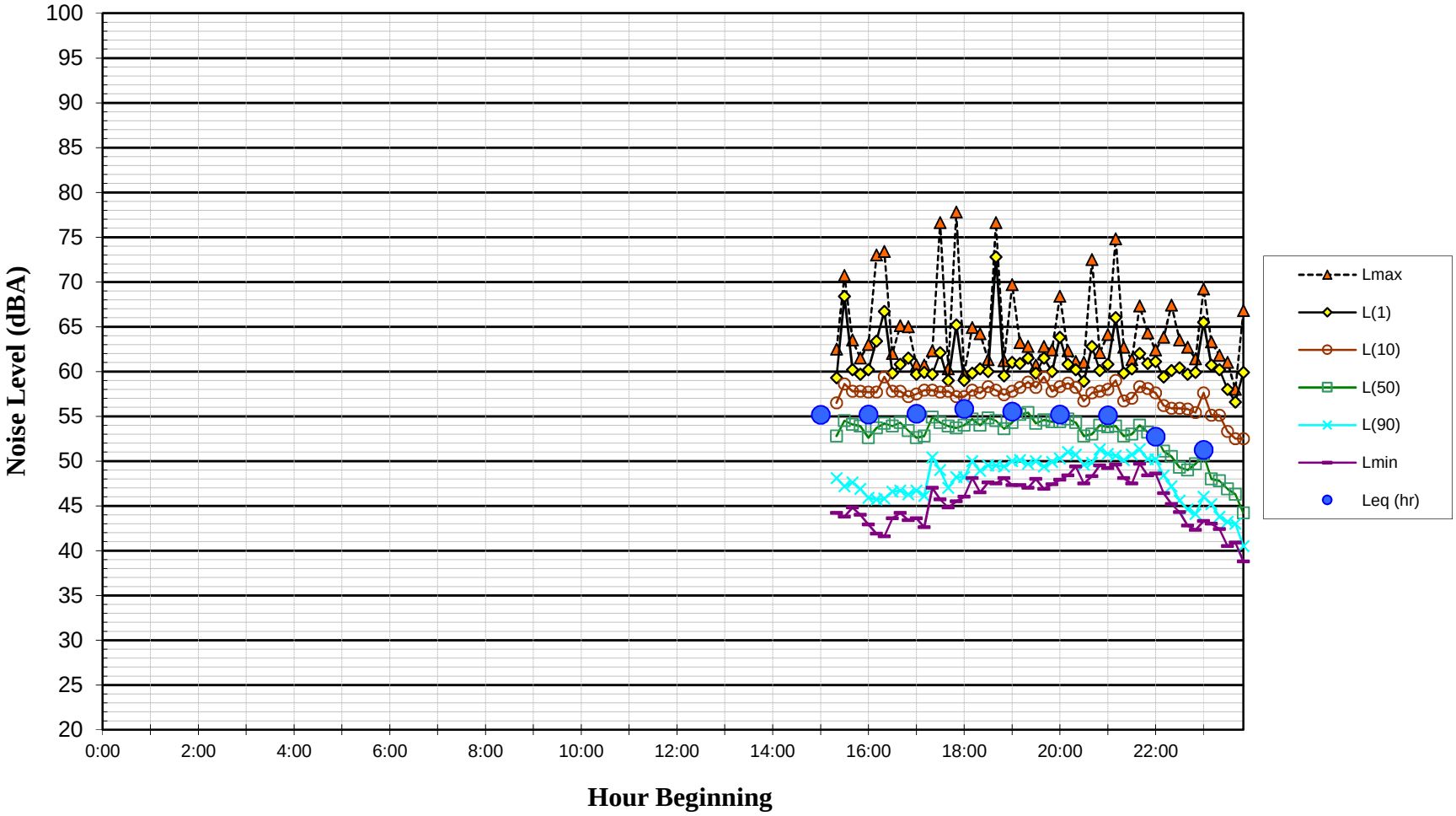
Implementation of the above measures would reduce this impact to a **less-than-significant** level.

FIGURE 3 Probability of Cracking and Fatigue from Repetitive Loading

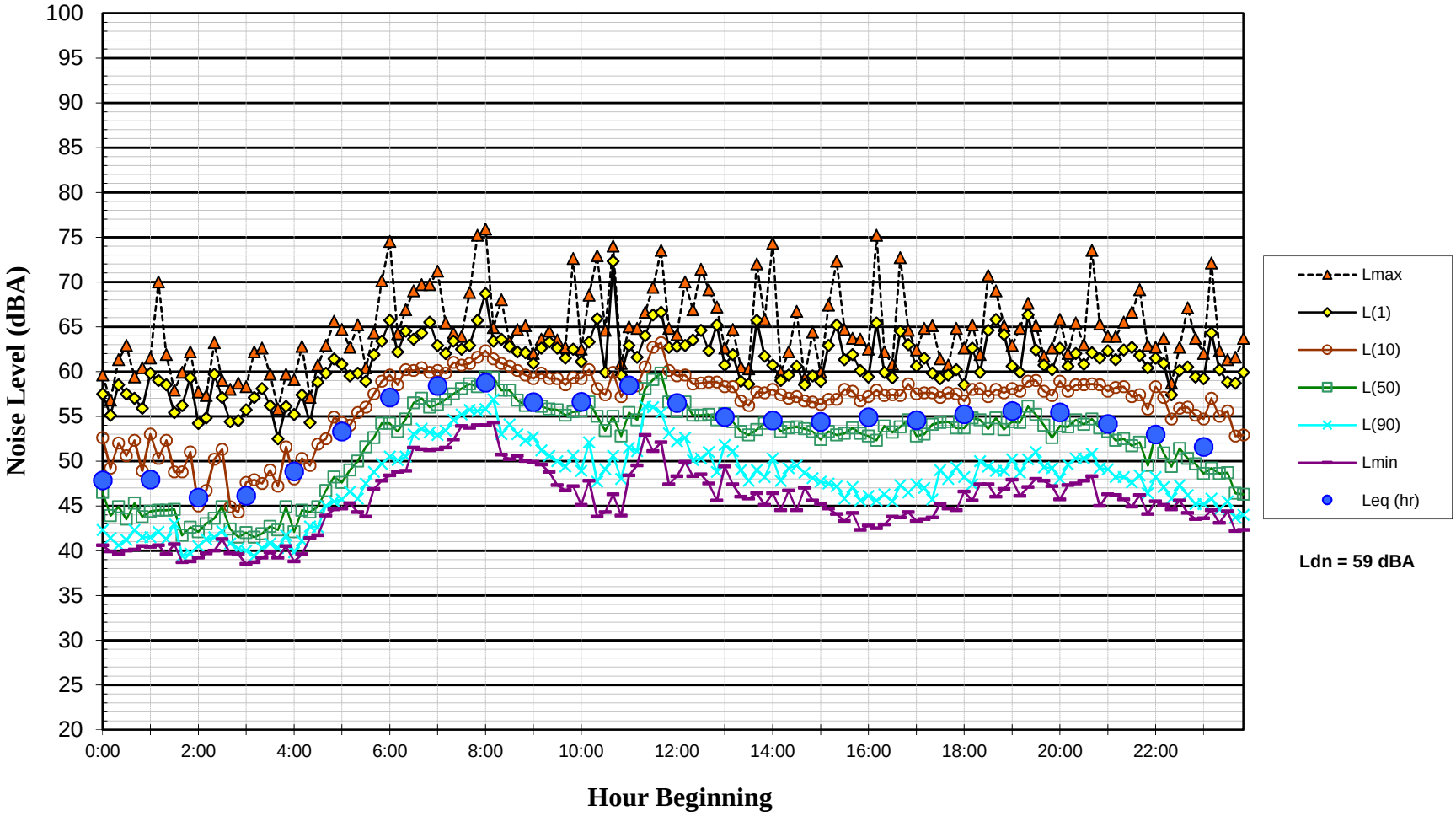


Source: Dowding, C.H., Construction Vibrations, Prentice Hall, Upper Saddle River, 1996 as modified by Illingworth & Rodkin, Inc., January 2019.

Noise Levels at Noise Measurement Site LT-1
Southwest corner of Site
Tuesday, January 22, 2019

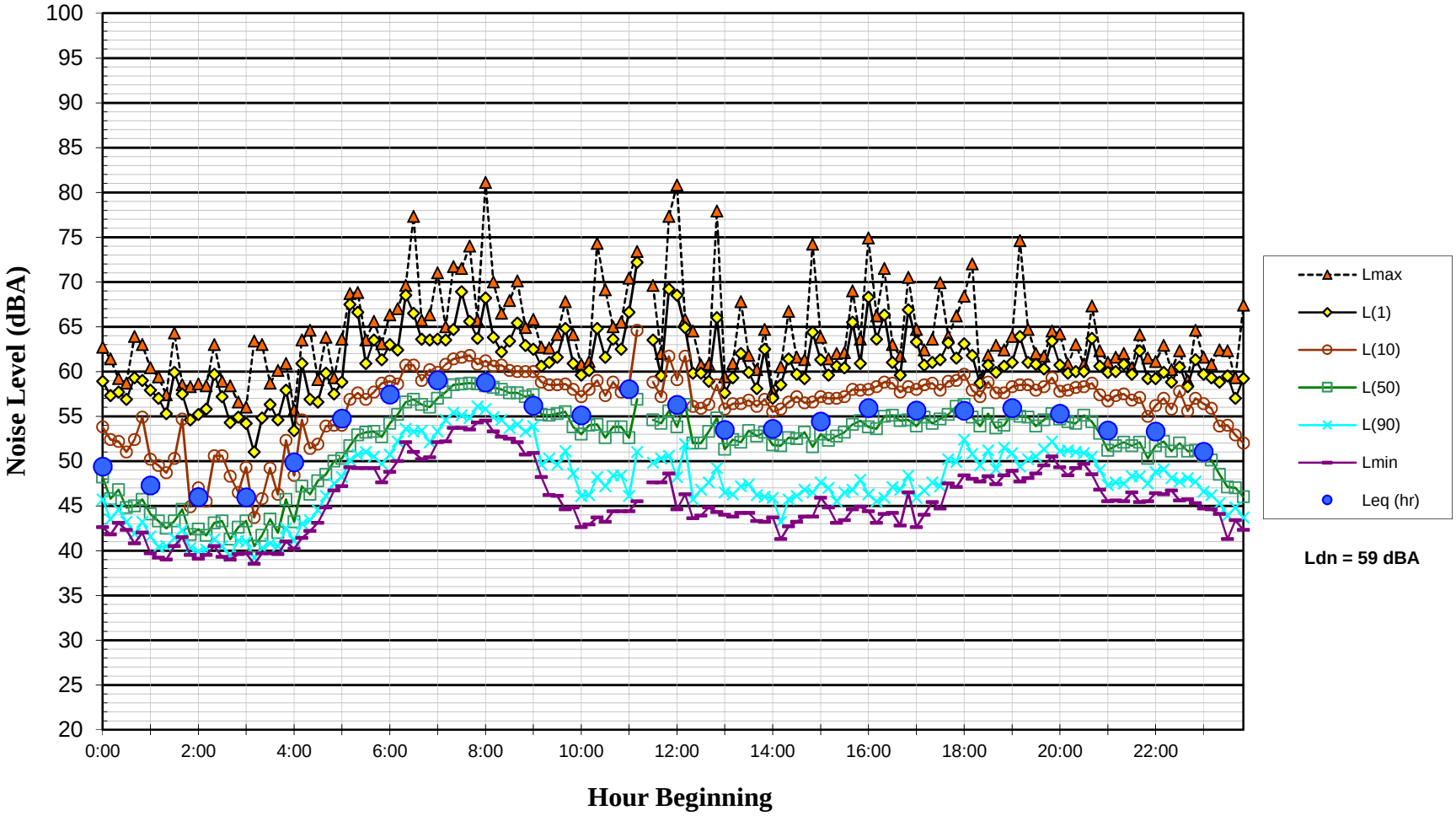


Noise Levels at Noise Measurement Site LT-1
Southwest corner of Site
Wednesday, January 23, 2019



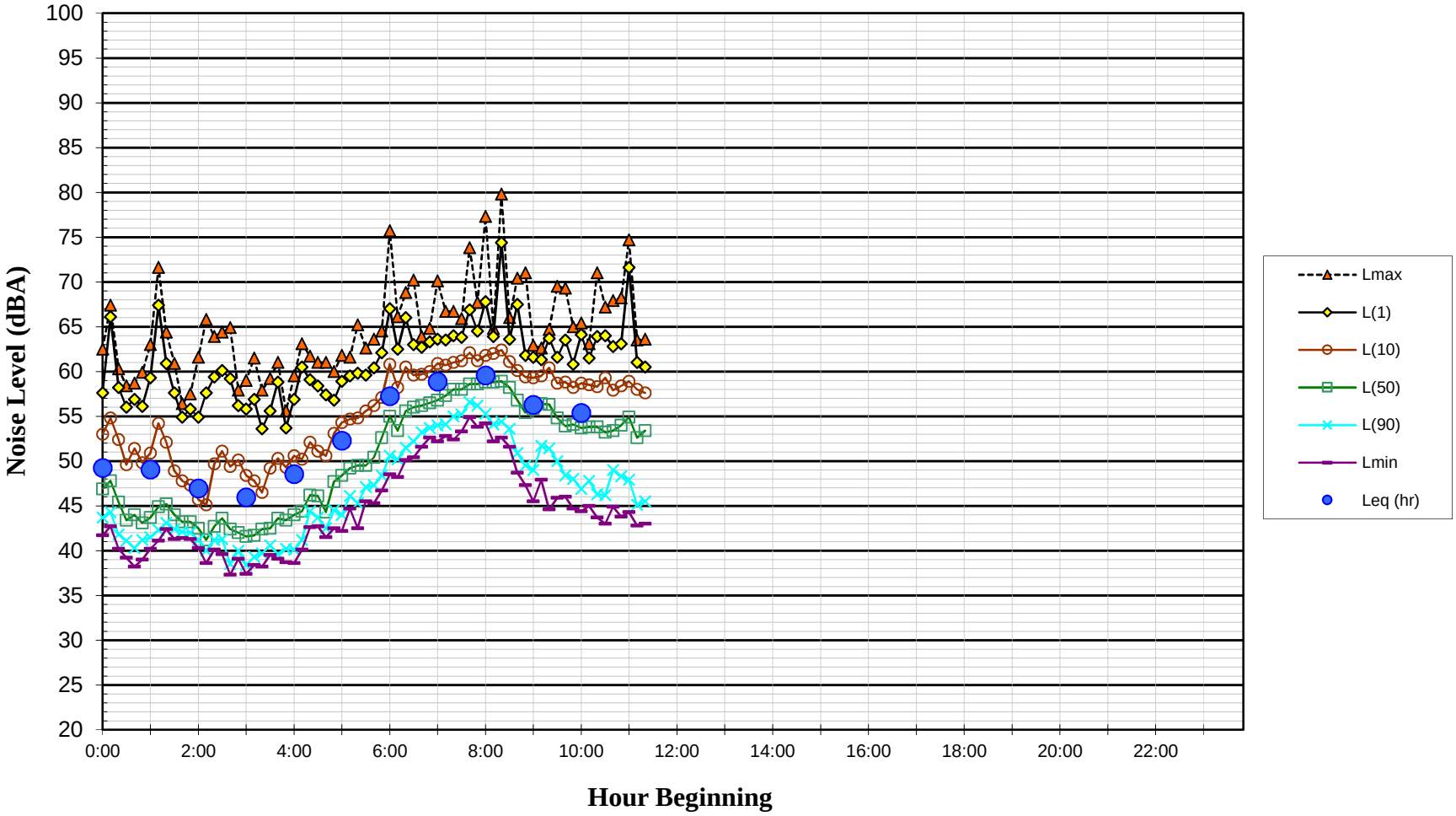
Ldn = 59 dBA

Noise Levels at Noise Measurement Site LT-1
Southwest corner of Site
Thursday, January 24, 2019

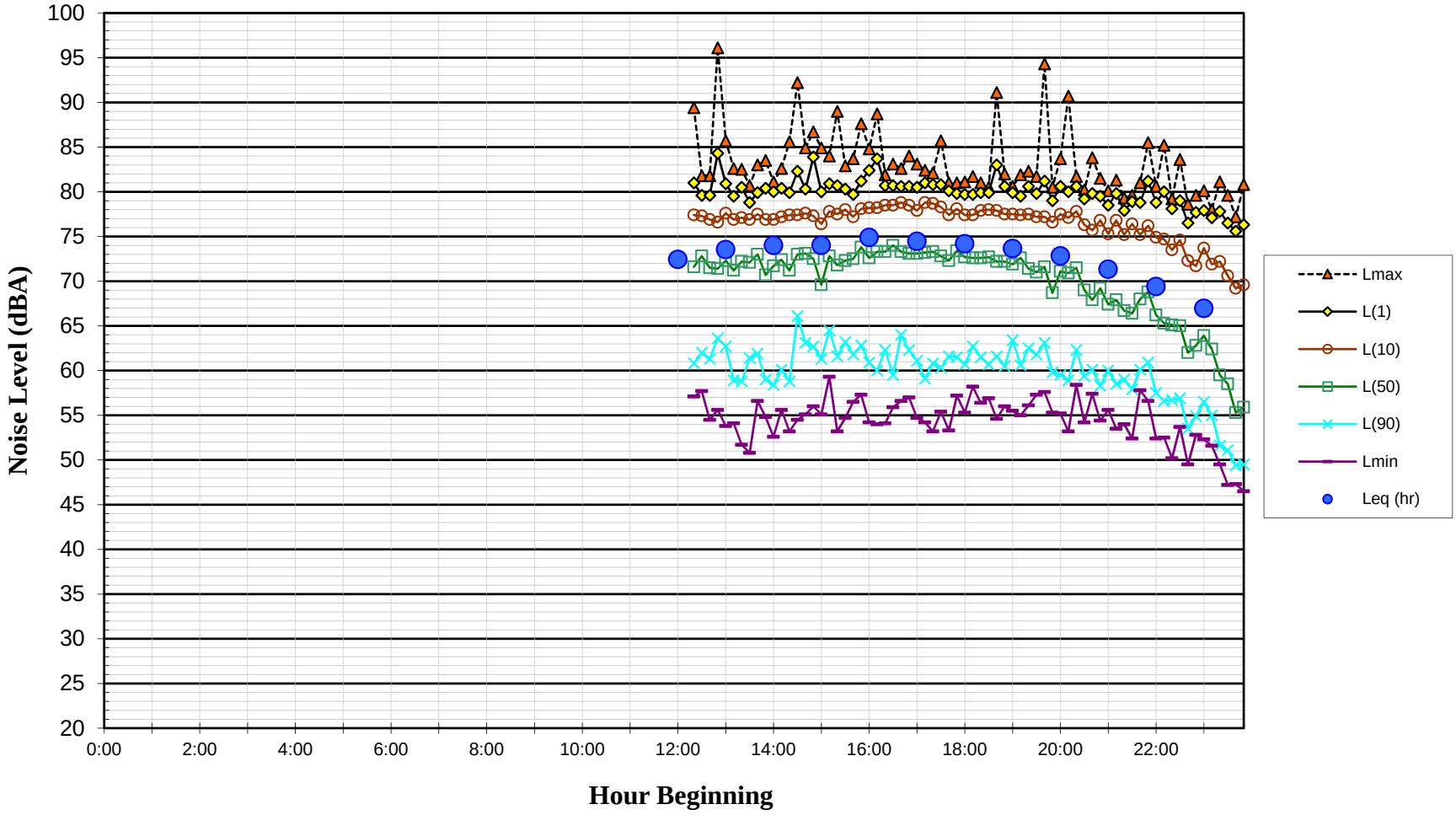


Ldn = 59 dBA

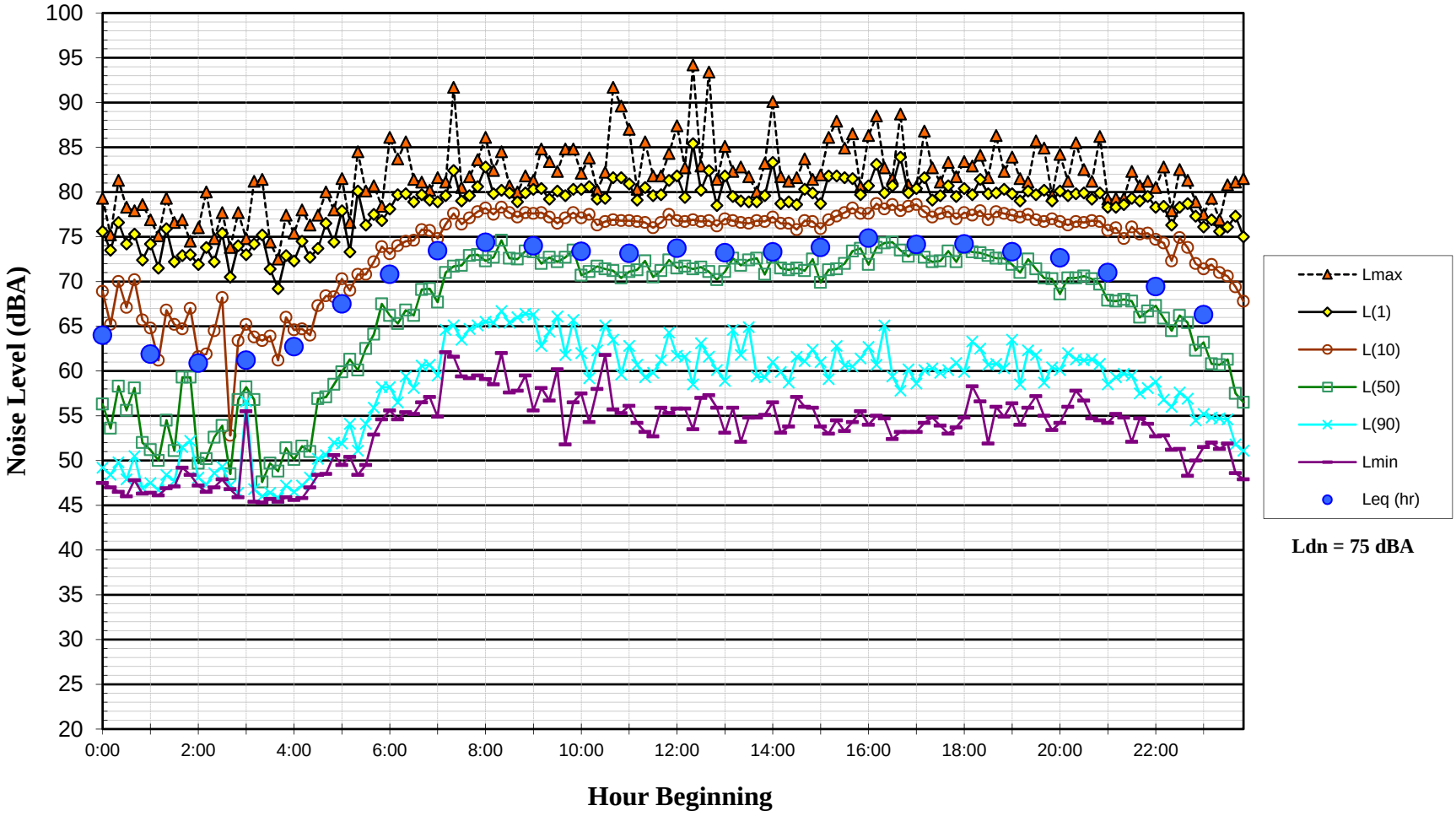
Noise Levels at Noise Measurement Site LT-1
Southwest corner of Site
Friday, January 25, 2019



Noise Levels at Measurement Site LT-2
50 feet from center of El Camino Real
Tuesday, January 22, 2019

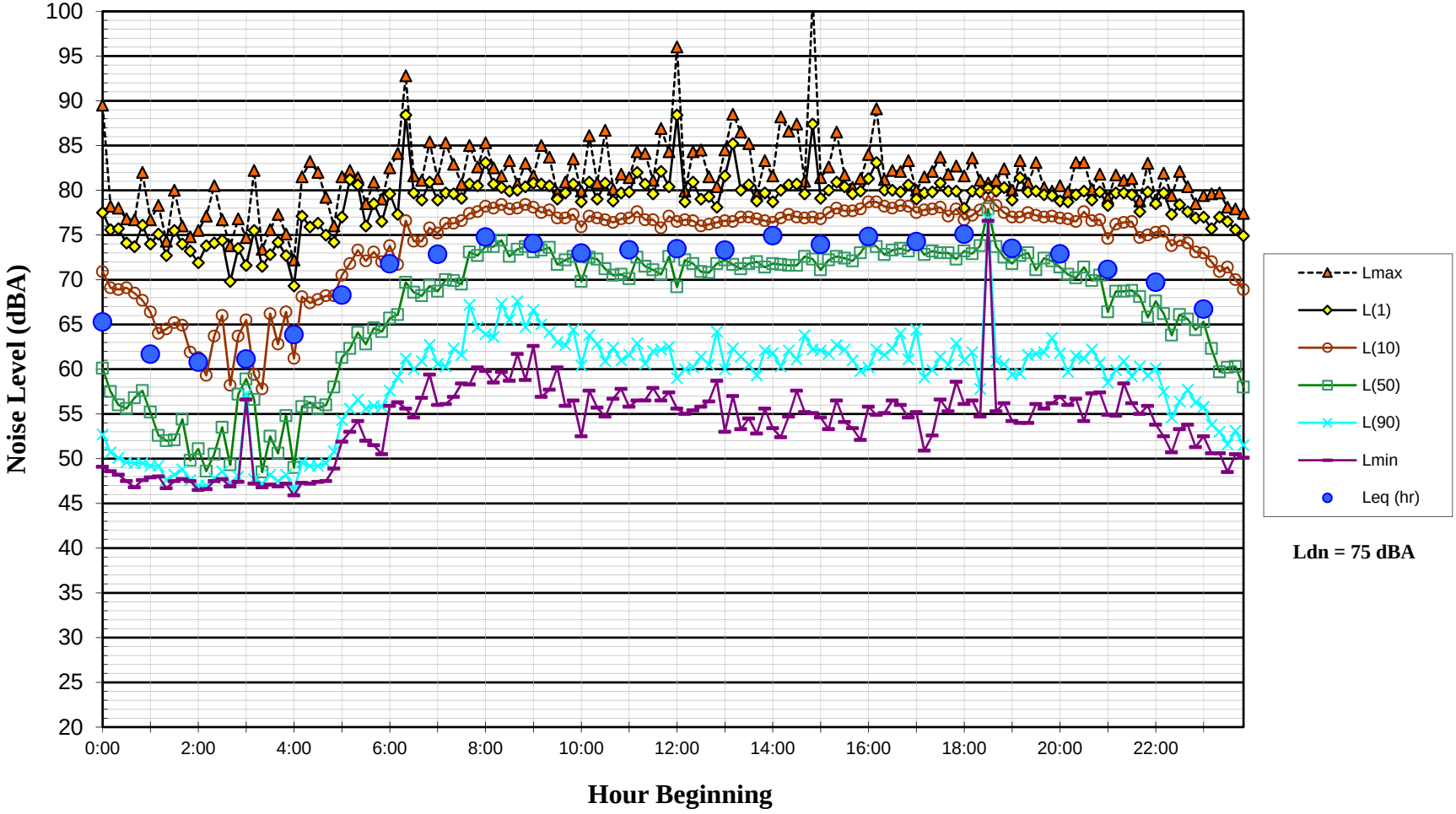


Noise Levels at Measurement Site LT-2
50 feet from center of El Camino Real
Wednesday, January 23, 2019

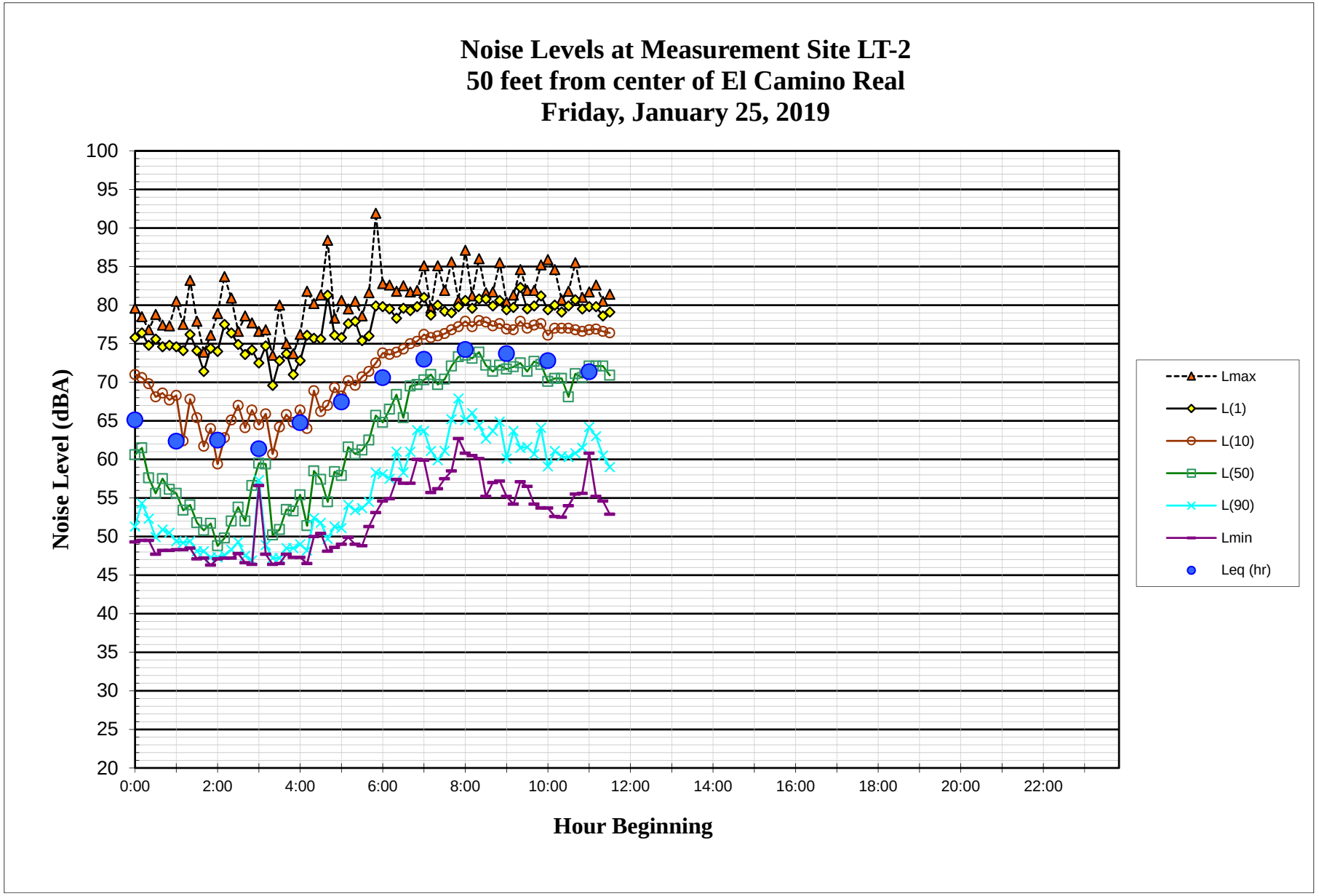


Ldn = 75 dBA

Noise Levels at Measurement Site LT-2
50 feet from center of El Camino Real
Thursday, January 24, 2019



Ldn = 75 dBA


Noise Levels at Measurement Site LT-2
50 feet from center of El Camino Real
Friday, January 25, 2019
Noise Level (dBA)
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
Hour Beginning
Lmax
L(1)
L(10)
L(50)
L(90)
Lmin
Leq (hr)